

Global “Sawtooth” Activity in the April 2002 Geomagnetic Storm

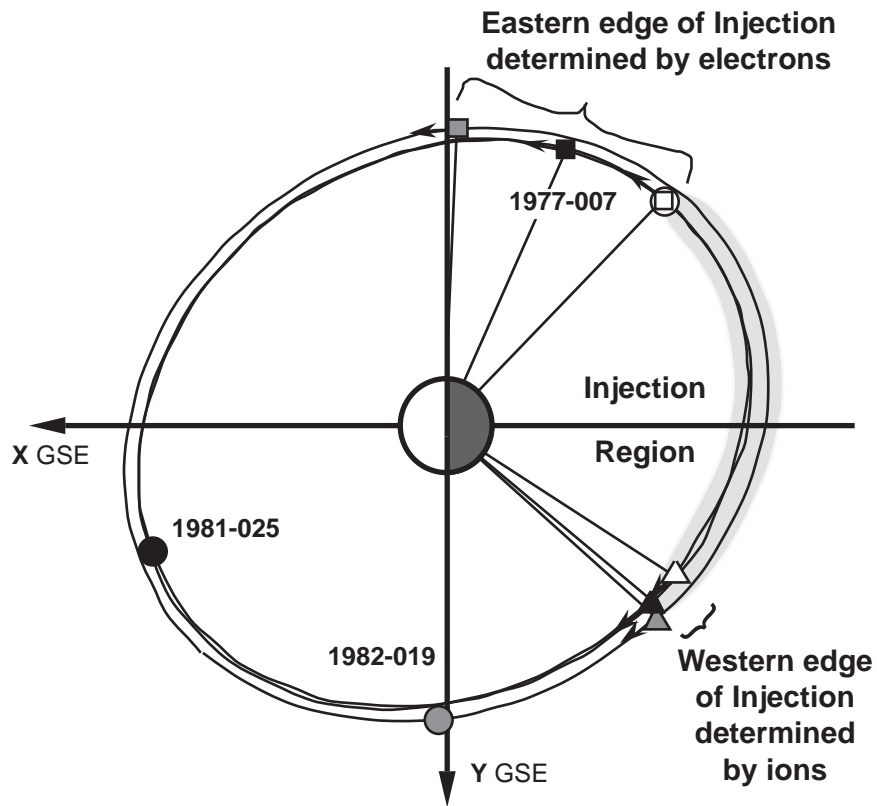


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Michelle Thomsen, Mike Henderson, Ruth. Skoug,
Joe Borovsky, Jörg-Micha Jahn, Craig Pollock,
Don Mitchell, Pontus C:son-Brandt,
Howard Singer, and Steven Mende

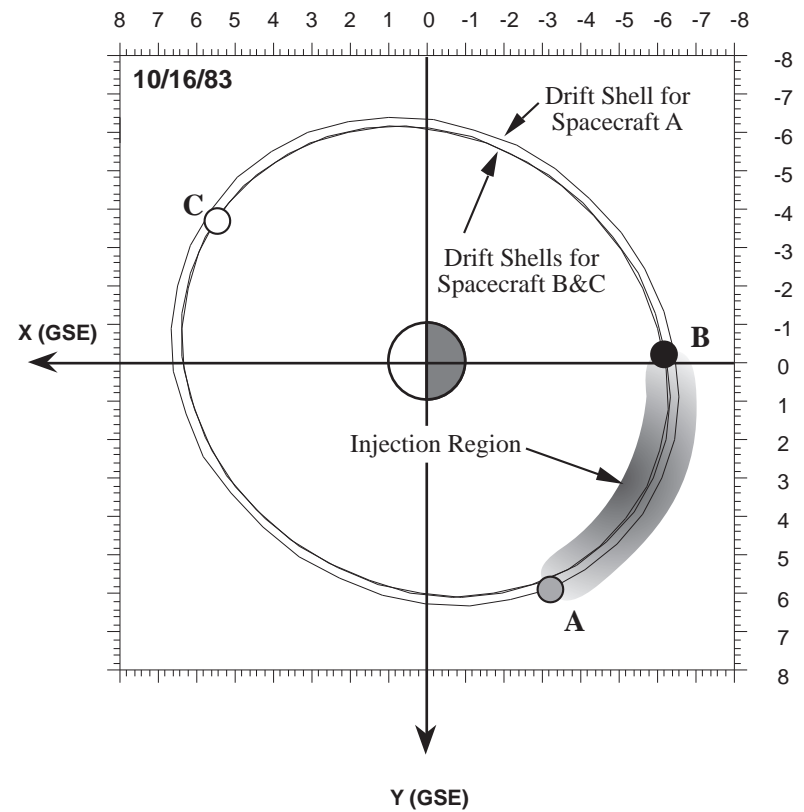
What are “Sawtooth” events?

- Strong injections of energetic particles
with sharp rise and slow decrease that look like a saw
in geosynchronous line plots
- Injections are quasi-periodic with periods of 2-4 hours
- Injections are global or nearly-global in local time extent
 - “How global” is the key question for this paper
- Teeth are most prominent in the high energy (>100 keV) ions
- Each “tooth” is associated with:
 - strong dipolarization of a very stretched field
 - auroral onset that is typically embedded in previous activity
 - increase in ENA fluxes
 - partial recovery of Dst/Sym-H
 - e.g. have substorm characteristics superposed on ongoing activity
- Sawtooth events occur during storms
 - can occur during different phases of the storm
 - seem to be associated with moderate & steady solar wind driving
 - have similarities to SMC conditions but are clearly not steady
 - sawtooth events **do not** occur in all storms

Two Examples of the Typical Size of the Substorm Injection Region



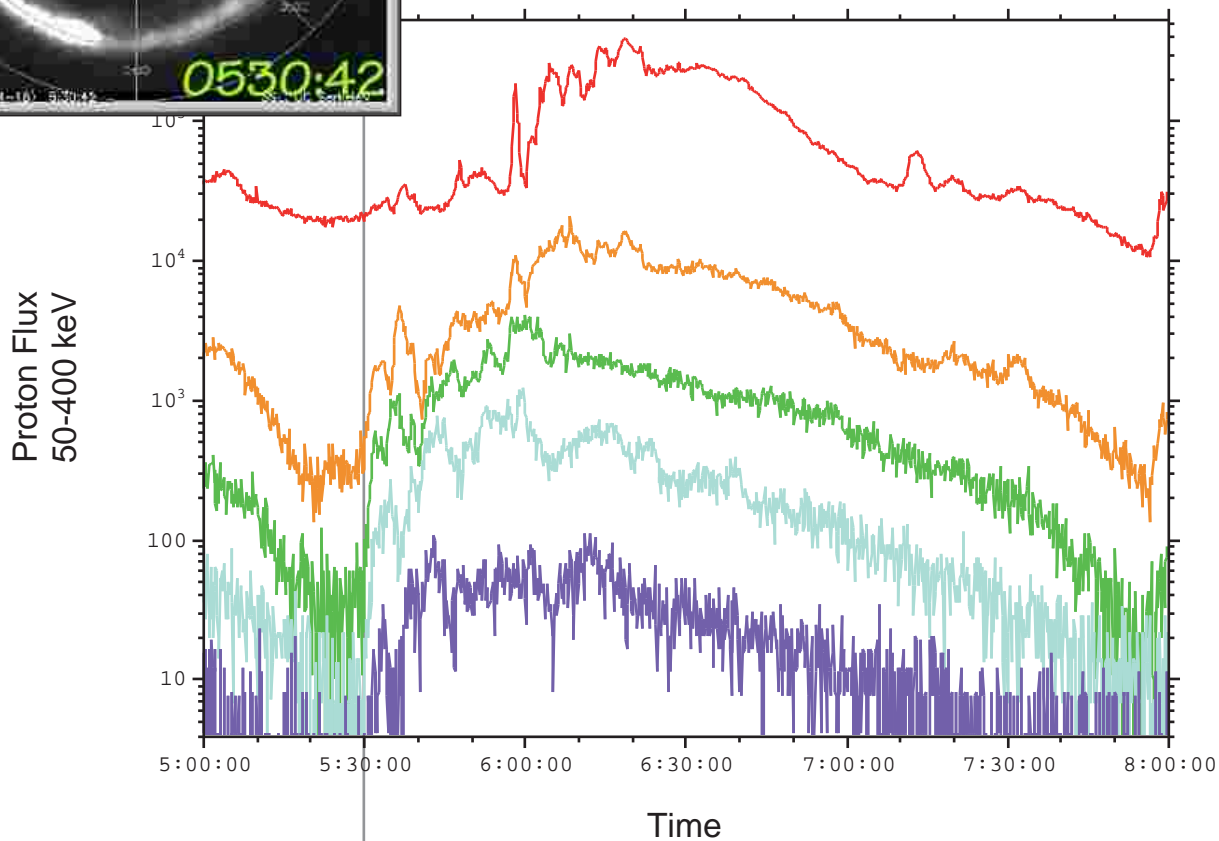
Reeves et al., GRL, 1990



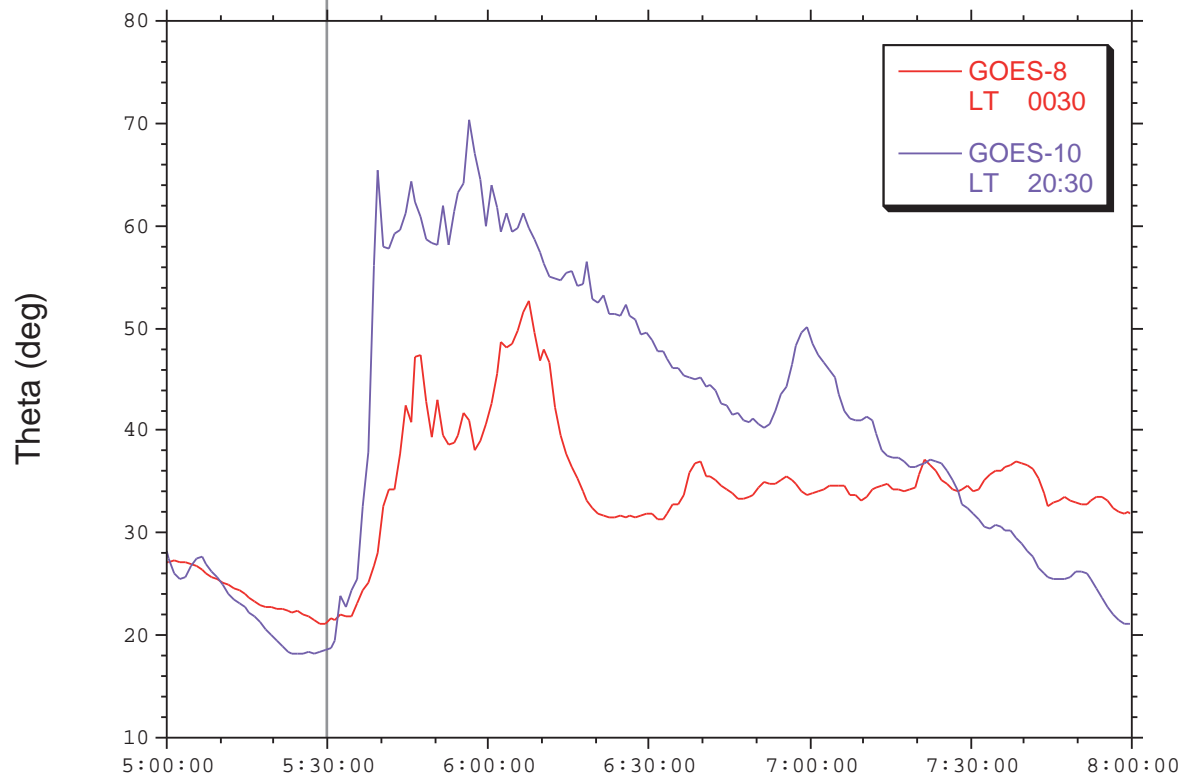
Reeves et al., JGR, 1991



1991-080 Protons
LT \approx 18:30



GOES Magnetic Field Angle

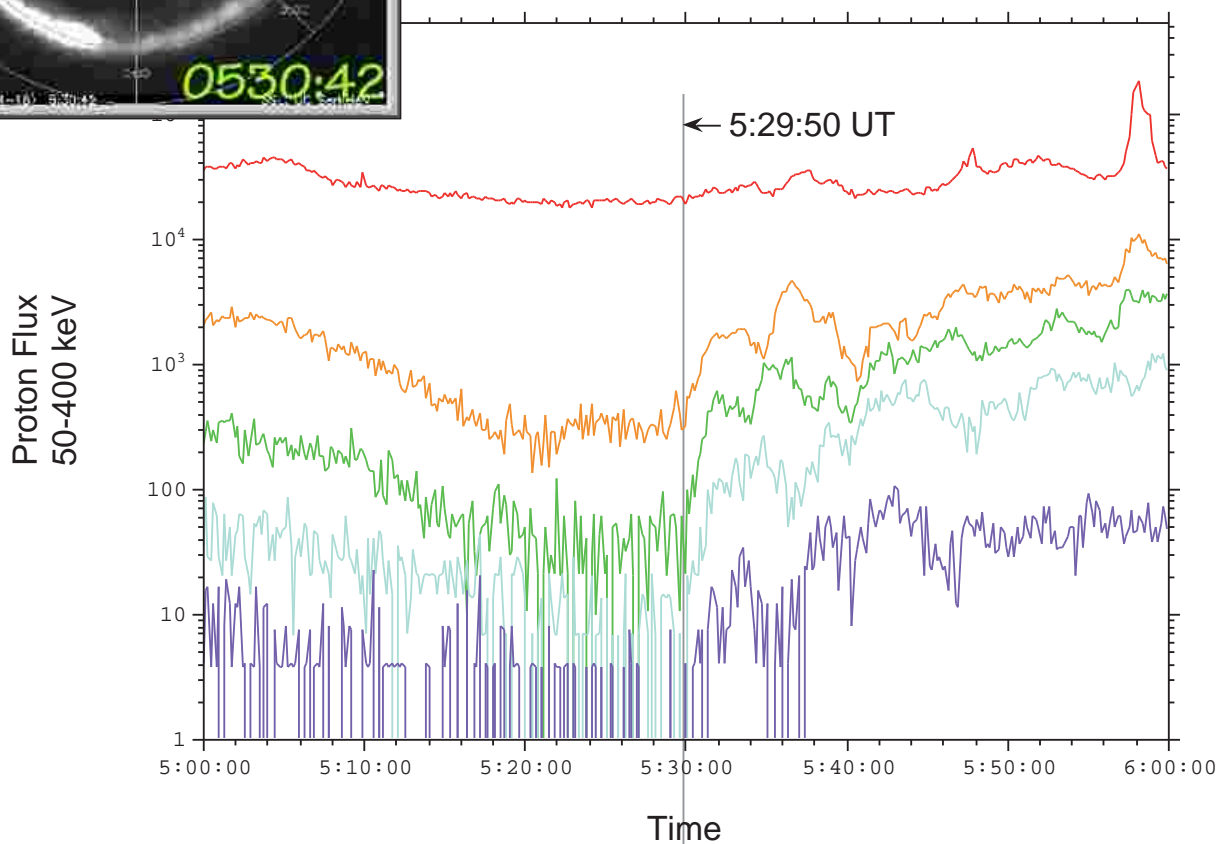


05:00

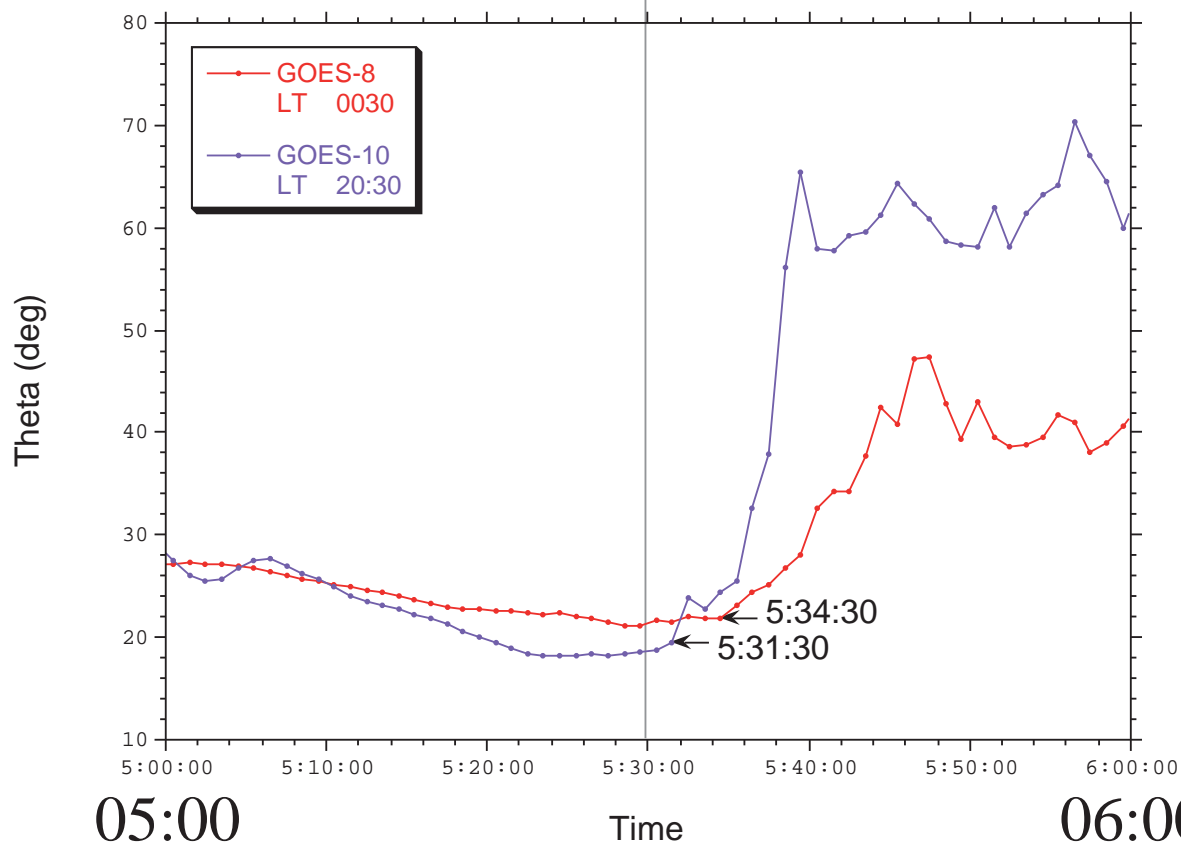
08:00



1991-080 Protons LT \approx 18:30

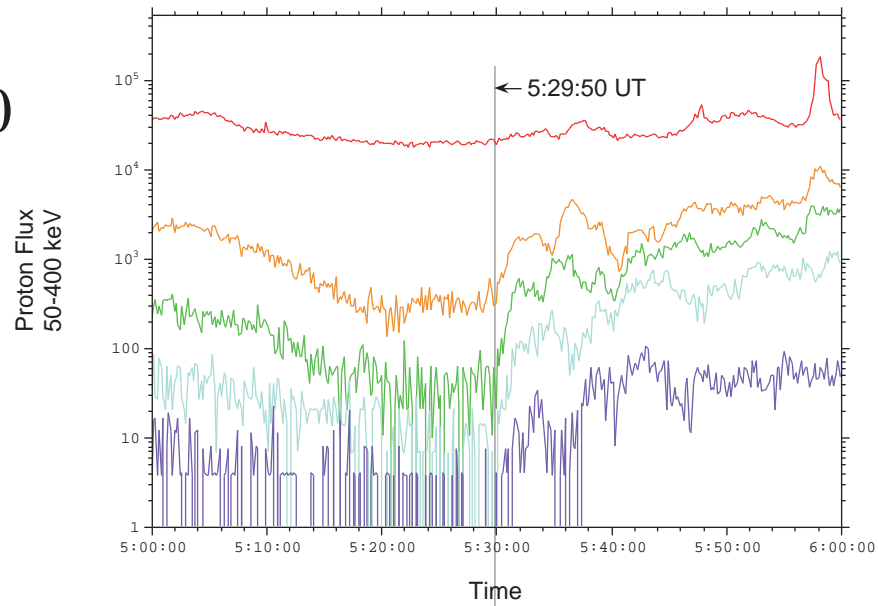


GOES Magnetic Field Angle

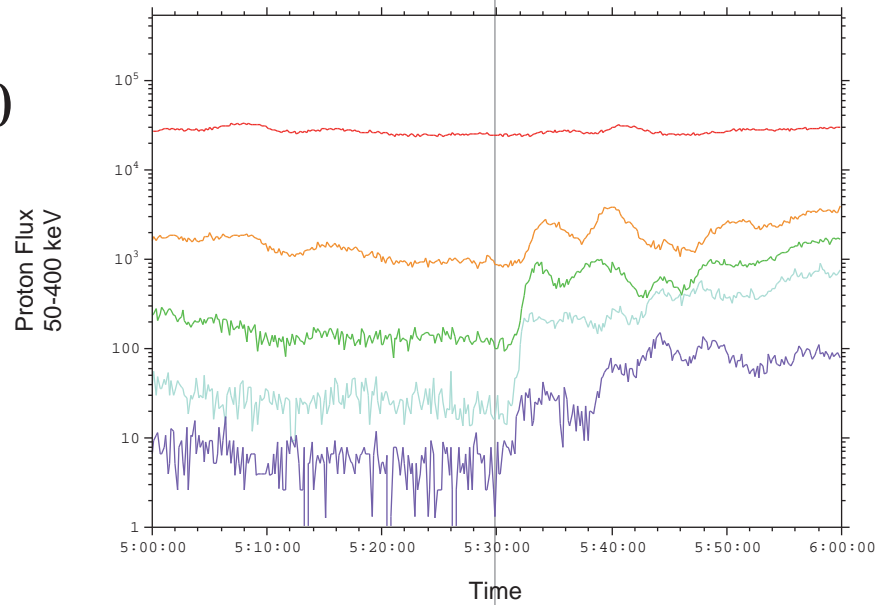


Proton Drift

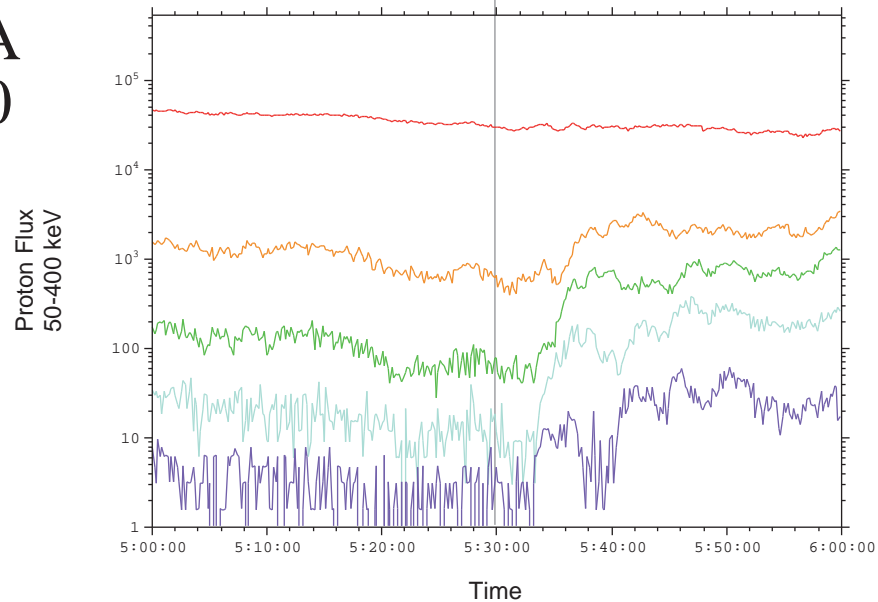
1991-080
LT \approx 18:30



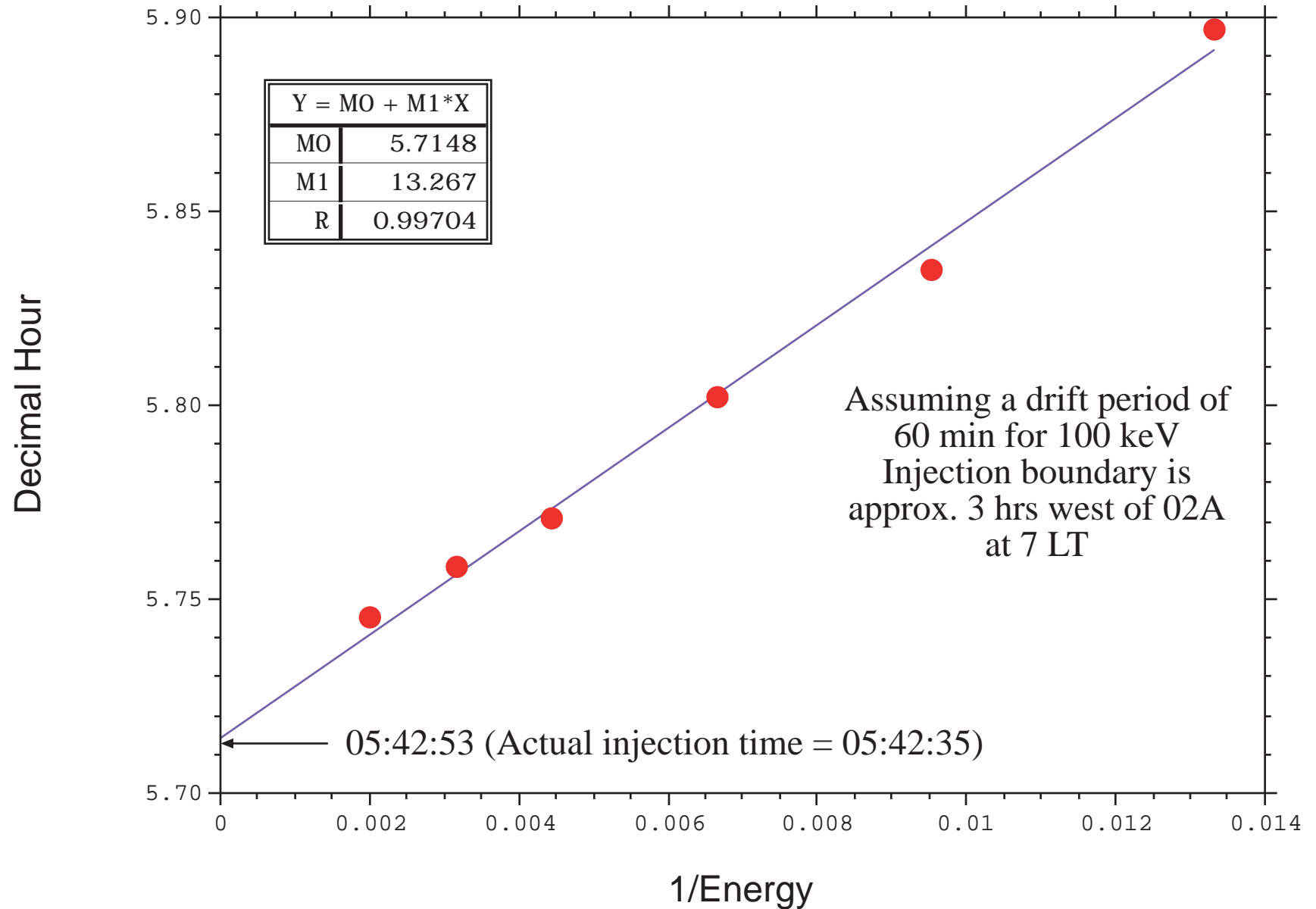
1994-084
LT \approx 15:00



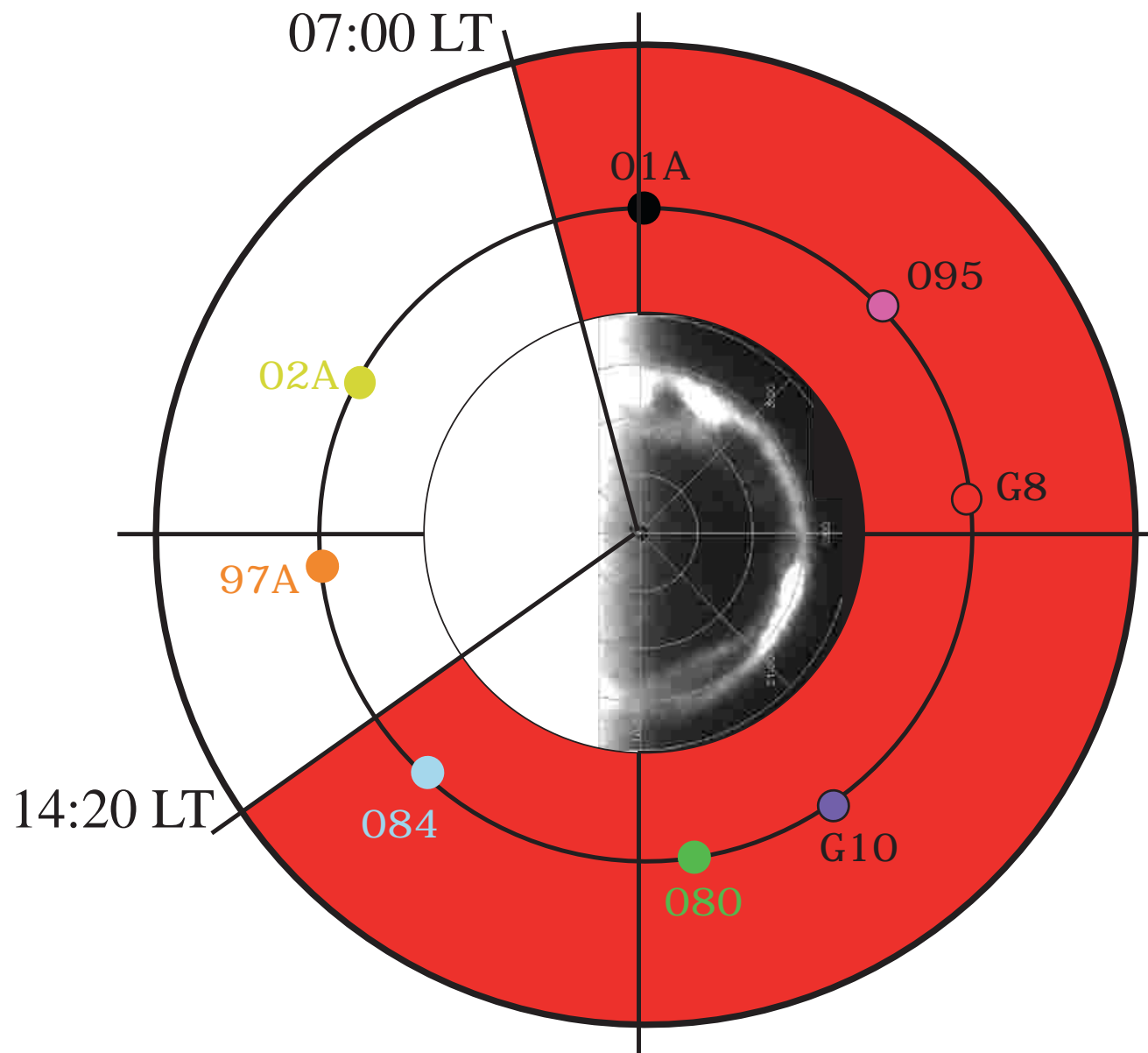
LANL-97A
LT \approx 12:20



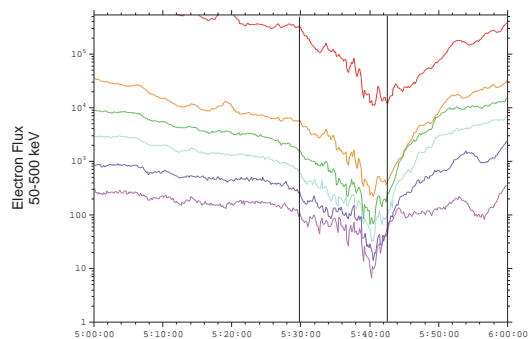
Dispersion Analysis



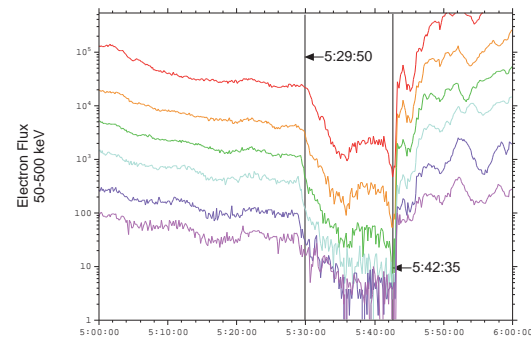
Approximate Size of the Injection Region 05:32 Sawtooth



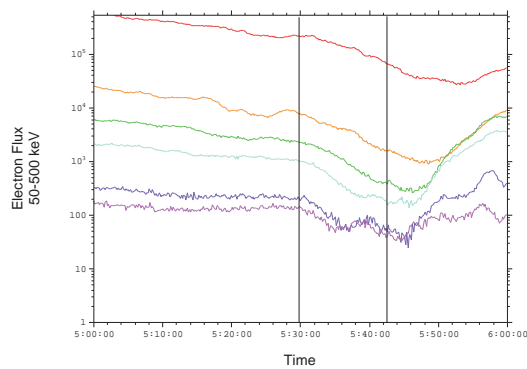
LANL-01A
LT \approx 06:00



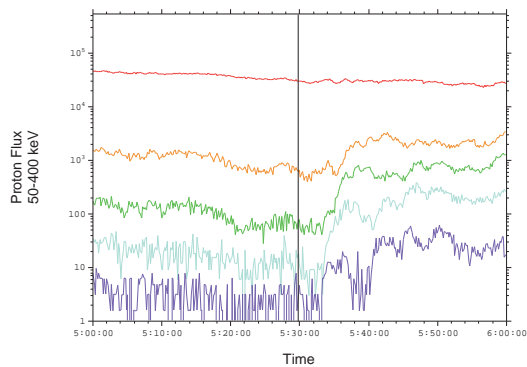
1990-095
LT \approx 03:00



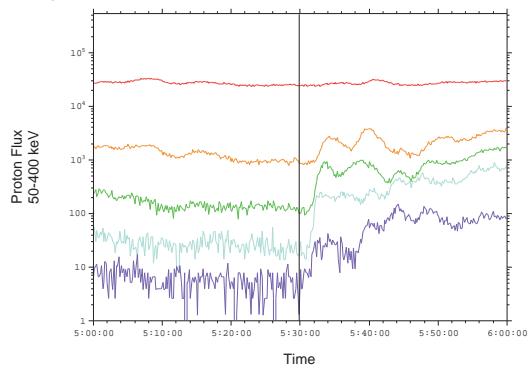
LANL-02A
LT \approx 10:00



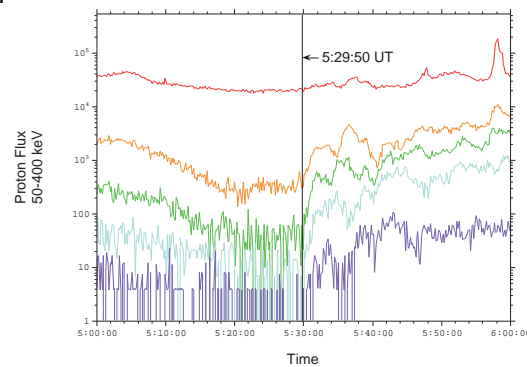
LANL-97A
LT \approx 12:20



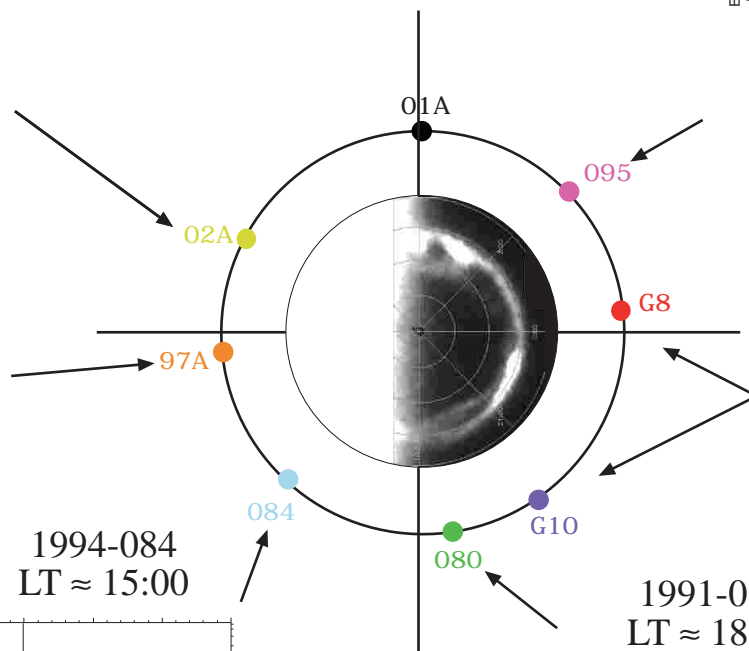
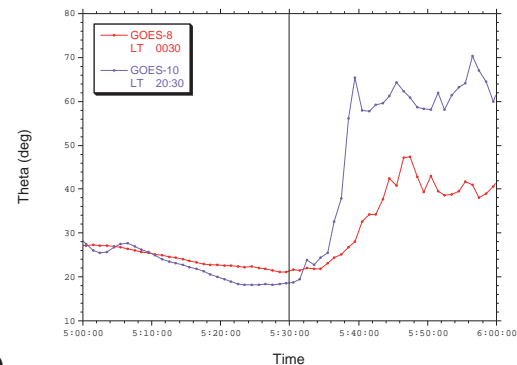
1994-084
LT \approx 15:00



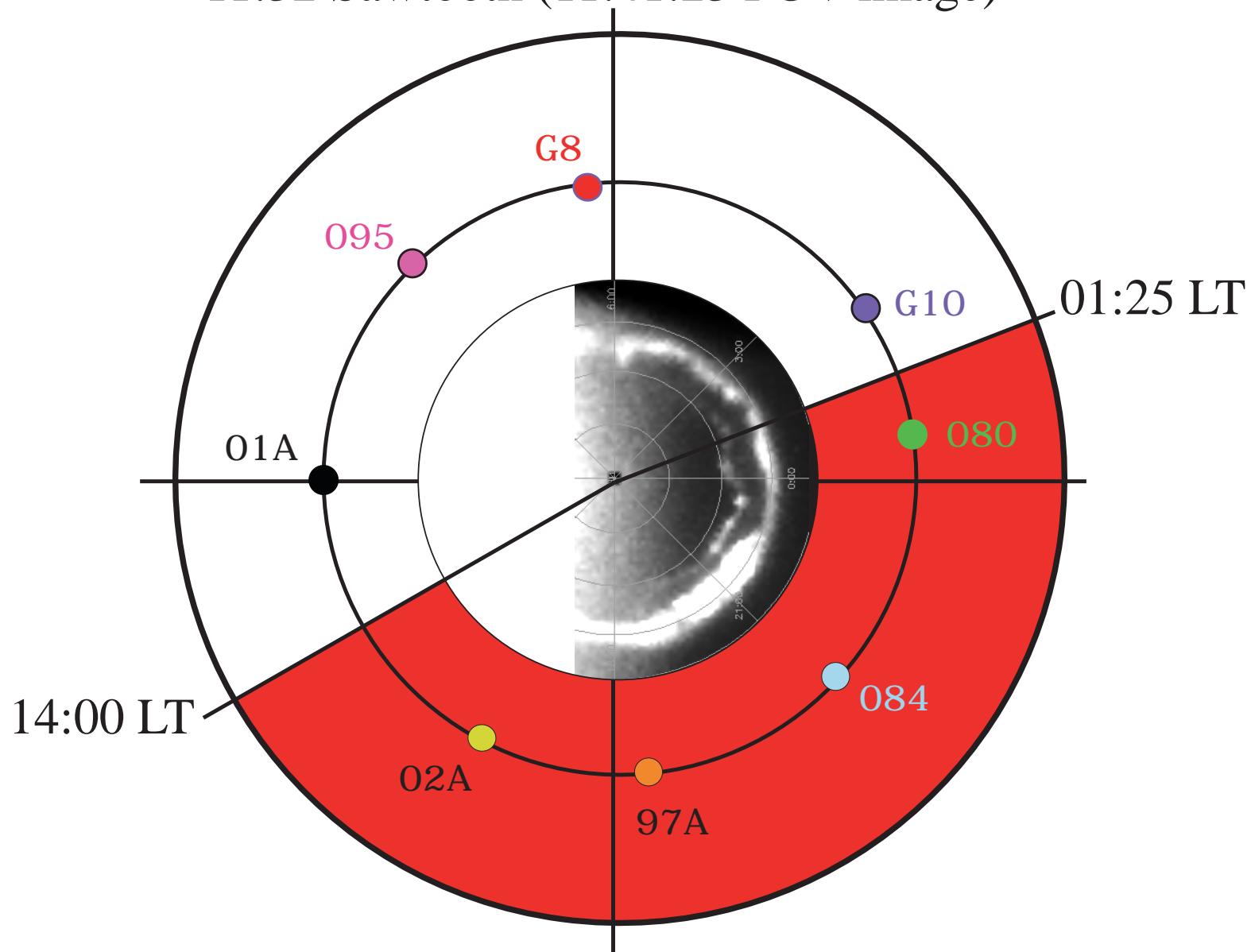
1991-080
LT \approx 18:30



GOES-8 & -10



Approximate Size of the Injection Region 11:32 Sawtooth (11:41:23 FUV image)



Conclusions

- The April 2002 storm includes a good example of sawtooth injections
- Analysis supports the conclusions from the October 2000 storm
- Each “tooth” is associated with classic substorm-like features
 - strong dipolarization of a very stretched field
 - auroral onset that is typically embedded in previous activity
 - increase in ENA fluxes
 - partial recovery of Dst/Sym-H
- Two “teeth” were examined in more detail
 - 6 LANL and 2 GOES provide extensive local time coverage
- The injection regions were much larger than isolated substorms
 - 16.7 and 11.4 hrs (250° and 170°)
- The injection onsets are complex and may “propagate”
 - sawtooth activity seems to be centered close to the dusk meridian
 - post-midnight activity can be delayed by ≈ 10 min
 - energy-dispersed drifts mean - new injection of trapped particles
 - not all flux increases are observed as drifting populations
 - only eastward propagation/expansion was documented here
- Questions:
 - what do the current systems look like for these events?
 - why are the sawtooth signatures so periodic?
 - how does the presence of sawtooth events relate to other features of the April 2002 storm?